SYSTEM AND METHOD FOR ENCODING INFORMATION INTO A VIDEO SIGNAL

Related Application

[0001] This application is based upon prior filed copending provisional application Serial No. 60/243,028 filed October 24, 2000.

Field of the Invention

[0002] This invention relates to the field of video signal encoding, and more particularly, this invention relates to a system for encoding information into a video signal by inserting new data content into an active portion of the video signal.

Background of the Invention

[0003] Television broadcasts, consumer video tape, different stored multimedia video formats, and live or taped over-the-air broadcasts are becoming increasingly more complex, having numerous channel formats, and increased requirements for adding new services and data associated with these systems. Different methods of

transmission have been used for inserting content data containing additional information into the video signals of various broadcasting formats, including National Television System Committee (NTSC),Digital Advanced Television Systems Committee (ATSC), Sequentiel Couleur a Memoire (SECAM), or Phase Alternation Line (PAL) compliant broadcasting formats. Both the active and blank portions have been used. Different modifications to the luminance and chrominance carriers have been commonly exploited, such as teletex, where textual information is substituted for the video portion of the signal in the active portion of the video signal.

[0004] Other known data insertion techniques include the insertion of data into the vertical and horizontal blanking intervals of a video signal. A well known example is a closed captioning system used primarily as an aid to the hearing impaired community. With this type of data insertion technique, textual data is encoded into the vertical blanking intervals.

[0005] These prior art techniques have been fully exploited by different vendors, and thus, an additional method of transporting any content data is required. One technique, as disclosed in U.S. Patent Nos. 5,663,766 and 5,929,920 to Sizer, II, assigned to Lucent Technologies Inc., adds a carrier signal that has been modulated by digital information into a video signal. This modulated carrier signal is at other than a frequency corresponding to a peak in the video spectrum. A receiver is arranged to sense optically the video signal and recover any encoded digital content data. Thus, the receiver optically views a screen luminance. This is not desirable

for some applications because a receiver/decoder in that application must optically view screen luminance to recover the encoded digital content data.

Summary of the Invention

[0006] The above-mentioned drawbacks are overcome by the present invention where an additional transmission channel is provided in the active portion of a video signal. This is accomplished without adversely affecting the visual content of any displayed video on an average consumer video display, such as a television. The video content is substituted with content data within the active portion of the video signal. For example, the luminance information is substituted with a modulated frame of content data on one or more lines of the active portion of a video signal rather than the vertical or horizontal blanking intervals. This provides the additional transmission channel for the content data.

[0007] In one aspect of the present invention, the system includes a data modulation and video synchronization circuit for converting content data into at least one modulated frame of content data having video synchronization information. An interleaver is operatively connected to this circuit for interleaving the modulated frame of content data within at least one selected line of a video data stream, which is modulated into a video signal compliant with broadcasting standards. A decoder receives the video signal that has been encoded with the content data and extracts the content data. The decoder includes a line deinterleaver for separating video lines from a video data stream into a modulated frame of

content data. A DC restoration circuit restores a DC bias level for any content data. A bit and frame synchronizer circuit synchronizes the modulated frame of content data, which is followed by a demodulator/decode circuit that demodulates and decodes the modulated frame of content data into the content data.

[0008] In yet another aspect of the present invention, a video signal decoder circuit receives a video signal that is compliant with a broadcasting format and converts the video signal into a video data stream to be encoded with content data. This video signal is compliant with a broadcasting format that comprises one of a National Television System Committee (NTSC), Digital Advanced Television Systems Committee (ATSC), Sequentiel Couleur a Memoire (SECAM), or Phase Alternation Line (PAL) compliant broadcasting format.

Brief Description of the Drawings

[0009] Other objects, features and advantages of the present invention will become apparent from the detailed description of the invention which follows, when considered in light of the accompanying drawings in which:

[0010] FIG. 1 is a block diagram of the system for encoding information into an exemplary National Television System Committee (NTSC) video signal and showing basic circuits of the invention including an interleaver and video signal formatting circuit.

[0011] FIG. 2 is another block diagram of a portion of the system for encoding information shown in FIG. 1 and showing in greater detail an exemplary video signal

formatting circuit for use with a National Television System Committee (NTSC) compliant broadcasting format.

[0012] FIG. 3 is a block diagram of a decoder that can be used in the present invention for extracting the content data from a video signal that has been encoded with content data in accordance with the present invention.

[0013] FIG. 4 is an example of a video frame showing a modulated frame of content data substituted within top and bottom video lines.

[0014] FIG. 5 is a high level flow chart illustrating a method of operation in accordance with the present invention.

[0015] FIG. 6 illustrates an active video frame for an AVI file or a CCIR data stream that can be used with the present invention.

[0016] FIG. 7 is an example of a line of information that can be substituted into a video line of the active video frame.

[0017] FIG. 8 is a table showing what kind of symbols can be generated for an interleaving process for the active video frame of FIG. 6.

[0018] FIG. 9 is an overall system view showing use of the present invention by a consumer at a residential premises.

Detailed Description of the Preferred Embodiments

[0019] The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention

are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

[0020] The present invention is advantageous and provides an additional transmission channel in the active portion of a video signal without adversely affecting the visual content of video display, such as an average consumer television or other video display device. It allows the substitution of certain amounts of video with content data within the active portion of a video signal. In its most general form, the present invention substitutes luminance information with a modulated frame of content data on one or more lines of the active portion of a video signal rather than on the vertical or horizontal blanking intervals as is typical in many prior art applications. This provides a beneficial and additional transmission channel for content data. As shown in FIG. 4, luminance information within the video signal has been substituted with a modulated frame of content data on one or more lines of the active portion of the video signal, preferably in the top and bottom video lines in the video signal. These lines typically correspond to the top or bottom of a video display that are substantially or partially shadowed from viewing.

[0021] The present invention can be used with many different types of video signals, including stored video tape, various multimedia formats, such as AVI files with

active video frames, and live or taped over-the-air broadcasts. Any broadcast video signal is preferably compliant with National Television System Committee (NTSC), Digital Advanced Television Systems Committee (ATSC), Sequentiel Couleur a Memoire (SECAM), or Phase Alternation Line (PAL) compliant broadcasting format video signals.

[0022] FIGS. 1-3 illustrate a basic block diagram of the overall system **10** of the present invention for encoding information as content data onto a video signal (FIGS. 1 and 2), and a decoder **12** (FIG. 3) used for decoding the video signal that has had a modulated frame of content data substituted onto one or more lines of the active portion of the video to provide the additional information channel.

[0023] Although the basic block circuit diagrams will vary depending on design changes made by those skilled in the art, the description will proceed relevant to a video signal that is compliant with the National Television System Committee (NTSC) broadcasting format standards.

[0024] As shown in FIG. 1, an NTSC video signal enters basic video processing circuits, as known to those skilled in the art, including a blanking interval processing circuit **14**, and luminance and chrominance processing circuit **16**. Y video information signals are forwarded from the luminance and chrominance processing circuit **16** into a horizontal and vertical synchronization and detection circuit **18**, using basic video processing circuitry, as known to those skilled in the art. A data conversion, buffering and synchronization circuit **20**

receives blanking information signals from the blanking interval processing circuit **14**, and Y and CrCb data from the luminance and chrominance processing circuit **16**. Detected signals are also received from the horizontal and vertical synchronization detection circuit **18**. The data conversion, buffering and synchronization circuit converts the broadcast compliant video signal into an appropriate video data stream for interleaving, as explained below. An OR circuit **22** allows processing of stored video data received from a stored video database **24**, and acts as a switch for choosing sources of video signals, or could merge video from the two sources.

[0025] Content data stored on an enhanced content database **26** and video from a live enhanced content data stream **28** are selected or merged in OR circuit **30** for later modulation within a modulation and video synchronization circuit **32**, labeled the Enhanced Data Encoder and Modulator. This circuit **32** converts the content data received from the enhanced content database **26** or live enhanced content data stream **28** into at least one modulated frame of data having video synchronization information to be passed to an interleaver **34**. This circuit **32** also adds any appropriate error coding information, such as by encapsulation, and video synchronization information, including bit and frame markers, by techniques known to those skilled in the art.

[0026] At the same time, a portion of the video data stream is passed to an interleave processing and control circuit **36** that works in conjunction with the modulation and video synchronization circuit **32** and the interleaver

34 for timing and proper interleaving of modulated frames of content data with the video data stream. The interleaver receives the video data stream from a buffer circuit **38** for proper buffering and timing and interleaves the modulated frame of content data within at least one selected line of the video data stream, as noted before.

[0027] As shown in FIG. 4, one aspect of the present invention allows interleaving of the modulated frame of data within the top and bottom video lines in a video signal corresponding to the top and bottom of a video display that is substantially shadowed from viewing. The digital video is output from the interleaver **34** into a video signal formatting circuit **40** that receives the video data stream after interleaving, and formats the video data stream by techniques known to those skilled in the art into a video signal that is compliant with a known broadcasting format. In the example of the present invention, as shown in FIG. 2, the broadcasting format is an NTSC broadcasting format. Naturally, other formats besides the listed NTSC, PAL, ATSC, or SECAM format can be used in the present ivention.

[0028] As shown in FIG. 2, where the video data stream is formatted into a video signal with the NTSC standard, the video signal formatting circuit includes a luminance and chrominance data separator circuit **42** that receives the digital video data stream from the interleaver **34.** It forwards separated data signals to the respective Y filter circuit **44** and C filter circuit **45**, which in turn is connected to the chroma modulator circuit **46**, as known to those skilled in the art. Copy protection information **48**

is added via summing circuits **50a, 50b** to the signal received from the Y filter circuit **44** and chroma modulator circuit **46**. A vertical blanking and interval data processing circuit **52** is connected to a summing circuit **54** that is connected to the Y filter summing circuit **50a** and outputs a luminance out signal. A part of this signal is forwarded to a summing circuit **56** that receives part of the copy protected chroma modulator signal from summing circuit **50b** for a composite out signal. A chrominance out signal is received from the summing circuit **50b**. This technique is known to those skilled in the art.

[0029] A decoder **12** that can be used with the present invention is shown in FIG. 3. The dashed line configuration illustrated at **60** corresponds to a standard video processing chip, such as an Intersil 8117 video processing chip. The chip **60** includes standard video processing functional components, including an automatic gain control and clamping circuit **62**. From that circuit **62**, the signal is processed with a blanking interval processing circuit **64**, luminance and chrominance processing circuit **66** for outputting Y data and Y and CrCb data, and a horizontal and vertical synchronization detection circuit **68** that receives the Y data. A data conversion, buffering and synchronization circuit **70** receives the blanking information from the blanking interval processing circuit **64**, Y and CrCb data from the luminance and chrominance processing circuit **66**, and the synchronization signals from the horizontal and vertical synchronization detection circuit **68**. This circuit **70** digitally processes the video signal into a video data

stream in accordance with techniques known to those skilled in the art.

[0030] A line separation and restoration circuit shown by dashed configuration **72** extracts the modulated frame of content data from the video data stream. As illustrated, a line deinterleaver circuit **74** separates video lines having the encoded content data from the video data stream into a modulated frame of data. A DC restoration circuit **76** restores the DC bias level for the content data. This circuit works as a DC process control and determines mid-level video information, such as whether it is RGB that has been converted to a single composite or luminance and what is available for use. Thus, luminance values can be peeled away at this point in time. The DC restoration is done on these values and can act as a secondary DC restoration because the top and bottom ranges can be known based on the incoming signal.

[0031] A bit and frame synchronizer circuit **76** determines frame markers and frame sequences as part of the encoding sequence. These had been encoded as part of the synchronization in the original encoding. This circuit can determine marker sequence and synchronize with an independent sampling rate by techniques known to those skilled in the art. As is known, it also can remove system noise and transmission artifacts by processing circuits and techniques. This bit and frame synchronizer circuit **78** can include an equalizer if higher order modulating techniques are used. A demodulator/decode circuit **80** demodulates and decodes the modulated frame of

data into the content data. The content data is thus retrieved.

[0032] FIG. 5 illustrates a basic high level flow chart showing the basic method of processing a video signal in accordance with the present invention. A video data stream is received to be enhanced with the content data (block **100**). The content data is received and converted into frames of content data (block **102**). Synchronization information and modulation data is added into the frame of content data to form a modulated frame of content data (block **104**). The modulated frame of content data is interleaved within at least one selected video line of the video data stream (block **106**). The video data stream is converted into a video signal and broadcast (block **108**). The video signal is received within a decoder (block **110**) and decoded into a video data stream (block **112**). The content data is extracted from the video data stream (block **114**).

[0033] Referring now to FIGS. 5-6, an interleaving process description is shown for interleaving AVI files. For example, in one aspect, it is assumed that an AVI file to be enhanced with the content data is opened such that individual frames of a video picture are available for modification. For example, the video could be 29.97 FPS, as an example, to operate. Several lines could be substituted in every frame of the AVI file. This AVI file could be constructed to have 480 by 720 RGB pixels to form an active video frame (FIG. 6), although other pixel resolutions can be used. The RGB pixel can be assumed to be a 15 bit pack representation, i.e., XRRRRRGGGGGBBBBB.

[0034] As shown in FIG. 7, a line of information that could be substituted into the video line includes a clock run-in as five symbols, synchronization data as 13 symbols, a synchronization guard as two symbols, a data ID as two symbols, a frame marker as two symbols, data content as 208 symbols, a reserved space of two symbols, and a clock run-out of four symbols, to form a total of 238 symbols with 714 RGB pixels, as a non-limiting example. This line can be inserted with the distinct data fields and can be generated such as from the table shown in FIG. 8. Naturally, different techniques to construct the frame marker and data field can be used as suggested by techniques known to those skilled in the art.

[0035] Although the description relative to FIGS. 6-8 describes an interleaving process for AVI files for use with MP3 audio data or other data, other techniques can be used as suggested to those skilled in the art.

[0036] FIG. 9 illustrates how a residential consumer located at a residential premises could use the system of the present invention. A recorded video source **150** or recorded description source **152** could be obtained from a standard video and encoded by a computer system **154** having appropriate encoding software and algorithms using the system of the present invention to form a broadband enhanced video content, which is then forwarded to a video master **156** for print or broadcast. The video tape or broadcast delivery allows consumer receipt at a residential premises in a standard VCR, DVD, DSS or cable unit **162** and the broadband enhanced video content is decoded in a broadband content decoder **166** of the present

invention. Decoder data is supplied to external receiving device **168** for further processing. A standard television **172** is shown as receiving the video signal.

[0037] Many modifications and other embodiments of the invention will come to the mind of one skilled in the art having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed, and that the modifications and embodiments are intended to be included within the scope of the dependent claims.